limitations of newly added claims 14-24 are new combinations of the already disclosed subject matter limitation in the currently pending claims.

New FIGURE 8 has been enclosed in the current preliminary amendment since original FIGURE 8 in the filed application has a section that was unintentionally printed as a black area. As described in the original disclosure of FIGURE 8 in the current application, the area as indicated by a pair of arrows C-C has been described to have gaps. Please note that on page 14, the original disclosure states "the coupling region with increasing the gap in the transversal direction together with widening of the width of the waveguides according to equation E1 and E2." Furthermore, revised FIGURE 8 has additional figure labels to help the identity of each figure within FIGURE 8.

New description of FIGURE 8 does not introduce any new matter. The revised description describes FIGURE 8 in a clear manner so that every part of FIGURE 8 is textually described. The new description only describes the originally disclosed features in FIGURE 8 and does not include any new matter.

Applicant respectfully submits that the current primary amendment is entered.

Respectfully submitted,

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FIGURE 8A is a schematic diagram that illustrates a fourth preferred embodiment, which includes a plurality of single-mode (SM) or multi-mode (MM) input waveguides 6 which is optically coupled with or connected to a plurality of diverging single-mode or multi-mode waveguides 12 at an input (B-B). At an output plane (not shown), the diverging waveguides 12 are optically connected to output waveguides. The width w2 of each of the diverging waveguides 12 is initially less than the critical width and then gradually increases to a width that is -larger than the critical width and after that to a width equal to that of its respective output waveguide to this end, the gaps between the waveguides 12 follow a pattern in accordance with equations E1

$$x = w_i\sqrt{1+(\alpha z)^2} \quad ;for \qquad x>0 \quad \alpha = \frac{(\lambda / n_{eff})}{\pi w_o} \quad ; \quad w_i = i(gap + wg); \qquad i = -10...10$$

The values used in the are w_0 = 1.0 μm; n= 3; λ = 1.545 μm; wg = 0.5 μm; and gap = 0.5 μm.

FIGURES 8B and 8C respectively show a cross sectional view of the waveguides along B-B and C-C as indicated by a corresponding pair of arrows. As shown in FIGURE 8B, a cross sectional view at the interface B-B shows that an inter-waveguide gap width w1 and a waveguide width w2 are substantially equal. On the other hand, a cross sectional

view at the diverging portion C-C shows that an inter-waveguide gap width w1 is smaller than a waveguide width w2.

FIGURES 8D and 8E respectively show a cross sectional view of the waveguides along dotted lines A-A and A'-A' as indicated by a corresponding pair of arrows. As shown in FIGURE 8D, a cross sectional view along the line A-A shows that an inter-waveguide gap gradually deepens as the waveguides 12 diverges. On the other hand, a cross sectional view along the line A'-A' shows that the waveguide surface of the waveguides 6 and 12 maintain the substantially horizontal plane.

~~Figure 8 shows the coupling region with increasing the gap in the transversal direction (x-direction) together with widening of the width of the waveguides according to equation E1 and E2. The increasing waveguide ridge enhances the lateral index contrast between the waveguide and the gap from nearly zero to a high number (e.g. from 0.01 or smaller to 1.0, or higher, both numbers depending heavily on the type of waveguide structure being used). This so-called transversal tapering of the gap in the coupling region allows to tailor the critical width of the waveguide across the coupling section, independently of the width of the waveguide ridge. At the input section of the coupling region, a low contrast is required to minimize optical~~

~~guiding (small ridge height of the waveguides), where as in the output section a high contrast is required to maximize optical confinement to the waveguide ridge region (high ridge height of the waveguides).~~

~~From the above explanations, it will be clear that in the optical couplers according to the present invention both the amplitude distribution and a phase distribution, at least at the output plane, are adjusted to accurately match the output waveguides and thus to operate at relatively low loss and cross-talk.~~

Further, the device described in this disclosure can be considered to operate reciprocal, thereby allowing to exchange inputs and outputs and reversing both direction of the light and the operation, e.g. in direction from right.

The invention is not restricted to the above-described embodiments, which can be varied in a number of ways within the scope of the claims.

10. The optical coupler according to any one of claim 1, 2 and 3, wherein the coupler, when electromagnetic radiation of a wavelength at which the coupler is designed to operate is launched in one of the inputs, generates (an end field with) an amplitude distribution, which exhibits, in a lateral direction, a plurality of peeks and wherein (the beginning of) the output waveguides are positioned at the lateral positions of these peaks.

11. The optical coupler according to claim 1, wherein the all the said waveguides are planar waveguides.

12. The optical coupler according to claim 1, wherein at least one of said optical coupler is used in an arrayed waveguide grating.

13. The optical coupler according to claim 1, wherein the width of the gaps between the waveguides is substantially constant, in combination with gradually increasing the lateral contrast between the waveguides.

<u>14. An optical coupler comprising:</u>

<u>at least one input waveguide, a coupling region optically connected to said input waveguide; and</u>

a plurality of output waveguides each optically connected to said coupling region, wherein said coupling region further comprises a plurality of coupled waveguides, at least some section of said coupled waveguides having a width that is less than a predetermined critical width at a predetermined wavelength at which said optical coupler is designed to operate, said coupled waveguides over at least another part of their lengths diverging with respect to each other in the propagation direction of electromagnetic radiation launched in the said input waveguide.

15. The optical coupler according to any one of claim 14, wherein centre lines of at least some of the gaps between the waveguides in a coupling region follow the lines of a Gaussian field in accordance with equations E1 as follows:

$$w(z) = w_k\sqrt{1+(\alpha z)^2} \quad ; \quad \alpha = \frac{(\lambda / n_{eff})}{\pi w_o^{\ 2}} \quad ; \quad R = z\left(1+\left(\frac{1}{\alpha z}\right)^2\right)$$

where z is the longitudinal propagation position; w(z) is the z-dependent lateral position of the central line of the k^{th} gap; w_k is the position of the centre of the k^{th} gap at z=0; w_o is the beam waist at z=0; λ is the wavelength in vacuum, n_{eff} is the effective index and R is the radius of

curvature of the phase front.

16. The optical coupler according to any one of claim 15, wherein the equations E1 include a linearised version and other mathematical approximation of the equations E1.

17. The optical coupler according to any one of claim 14, wherein the centre lines of a gap between the waveguides in the coupling region follow the lines of a field in accordance with equations E2 as follows:

$$w(z) = \begin{cases} w_k & , \quad \text{for } z < z_k \\ w_k\sqrt{1+[\alpha(z-z_k)]^2} & , \quad \text{for } z <= z_k \end{cases} \quad ; \quad \alpha = \frac{(\lambda / n_{eff})}{\pi w_o^{\ 2}}$$

where z is the longitudinal propagation position; w(z) is the z-dependent lateral position of the central line of the k^{th} gap; w_k is the position of the centre of the k^{th} gap at z=0; w_o is the beam waist at z=0; λ is the wavelength in vacuum, n_{eff} is the effective index and R is the radius of curvature of the phase front.

18. The optical coupler according to any one of claim 17, wherein the equations E2 include a linearised

version and other mathematical approximation of the equations E2.

19. An optical coupler comprising:

at least one input waveguide, a coupling region optically connected to said input waveguide; and

a plurality of output waveguides each optically connected to said coupling region, wherein said coupling region further comprises a plurality of coupled waveguides, at least some section of said coupled waveguides having a width that is less than a predetermined critical width at a predetermined wavelength at which said optical coupler is designed to operate.

20. The optical coupler according to any one of claim 19, wherein said coupled waveguides over at least another part of their lengths diverging with respect to each other in the propagation direction of electromagnetic radiation launched in the said input waveguide.

21. The optical coupler according to any one of claim 20, wherein centre lines of at least some of the gaps between the waveguides in a coupling region follow the lines

of a Gaussian field in accordance with equations E1 as follows:

$$w(z) = w_k \sqrt{1+(\alpha z)^2} \quad ; \quad \alpha = \frac{(\lambda / n_{eff})}{\pi w_o^{\ 2}} \quad ; \quad R = z\left(1+\left(\frac{1}{\alpha z}\right)^2\right)$$

where z is the longitudinal propagation position; w(z) is the z-dependent lateral position of the central line of the k^{th} gap; w_k is the position of the centre of the k^{th} gap at z=0; w_o is the beam waist at z=0; λ is the wavelength in vacuum, n_{eff} is the effective index and R is the radius of curvature of the phase front.

22. The optical coupler according to any one of claim 21, wherein the equations E1 include a linearised version and other mathematical approximation of the equations E1.

23. The optical coupler according to any one of claim 20, wherein the centre lines of a gap between the waveguides in the coupling region follow the lines of a field in accordance with equations E2 as follows:

$$w(z) = \begin{cases} w_k & , \quad \text{for } z < z_k \\ w_k \sqrt{1+[\alpha(z-z_k)]^2} & , \quad \text{for } z <= z_k \end{cases} \quad ; \quad \alpha = \frac{(\lambda / n_{eff})}{\pi w_c^{\ 2}}$$

where z is the longitudinal propagation position; w(z) is the z-dependent lateral position of the central line of the k^{th} gap; w_k is the position of the centre of the k^{th} gap at z=0; w_o is the beam waist at z=0; λ is the wavelength in vacuum, n_{eff} is the effective index and R is the radius of curvature of the phase front.

24. The optical coupler according to any one of claim 23, wherein the equations E2 include a linearised version and other mathematical approximation of the equations E2.

FIG. 8A

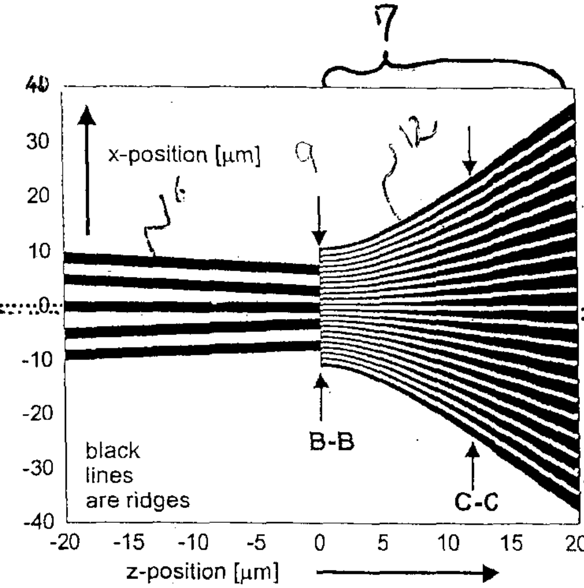

FIG. 8B

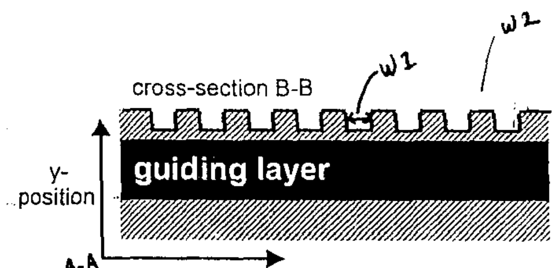

FIG. 8C

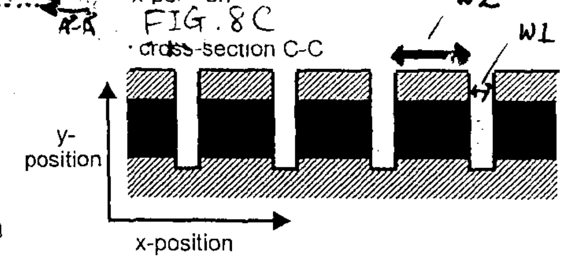

FIG. 8D

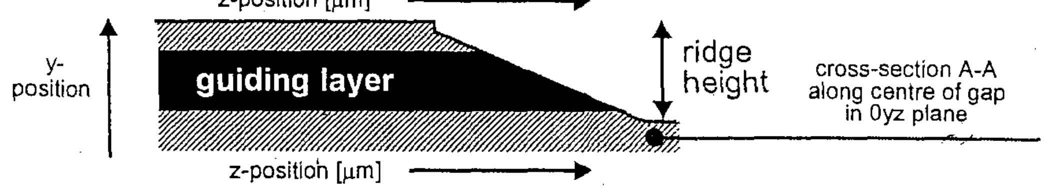

FIG. 8E